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ABSTRACT

Instructional Technology is a field of innovation. As instructional technologists realize that their innovations are not always readily adopted, theories of diffusion and adoption have been incorporated into instructional development models. This paper describes five unexplored areas of research related to the adoption and diffusion of innovations, specifically on the gaps in the literature in instructional settings: (1) Interaction of Adopter Groups; (2) Adoption Versus Retention; (3) Product Versus Process; (4) Technical and Societal Accommodations; and (5) Perspectives of Innovation. For each of the five areas, the authors provide an overview, a sample research question, a hypothetical case, and a description of one or more methodologies that might be appropriate to examine the question. The paper also includes a discussion of the contributions that diffusion theory has made to the field of instructional technology. (Contains 18 references.) (AEF)

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Diffusion of Instructional Innovations: Five Important, Unexplored Questions

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Abstract

This paper describes five unexplored areas of research related to the adoption and diffusion of innovations. The paper focuses specifically on gaps in the literature related to the adoption and diffusion of innovations in instructional settings. For each of the five questions, the authors provides an overview, a sample research question, a hypothetical case, and a description of one or more methodologies that might be appropriate to examine the question. The paper includes a discussion of the contributions that diffusion theory has made to the field of instructional technology.

Diffusion of Instructional Innovations: Five Important, Unexplored Questions

Instructional Technology is, in many respects, a field of innovation. Instructional technologists have, for a number of years, been involved with developing and promoting innovative tools and practices. Programmed instruction, distance learning, large-group instruction, computer-assisted instruction, constructivism, and web-based instruction are only a few of the many innovations developed, or at least popularized, by instructional technologists over the years. Recently, as instructional technologists have begun to realize that their innovations were not always readily adopted, theories of diffusion and adoption have gradually begun to be incorporated into instructional development models (Burkman, 1987). These theories have been used to guide projects ranging from the implementation of large-scale school reform efforts to the adoption of various instructional products.

The study of adoption and diffusion has a long and respected literary history. Investigations into why and how innovations are used have been conducted in a wide variety of fields and have provided many valuable insights. An extensive theoretical framework on the subject has been developed. In spite of the growing amount of diffusion research, or perhaps because of it, there are still many questions that are unanswered and several glaring holes in the adoption literature as it relates to instructional technology. Simply put, there is still a lot we don't know about why instructional innovations are adopted or rejected.

Contributions of Adoption and Diffusion Literature

Because this paper deals primarily with holes in the literature, it might be helpful to begin by describing some of the positive contributions diffusion theory has made to the field of instructional technology (IT). The primary contribution of the diffusion literature to the field is, without question, the concept that adoption and diffusion are part of a process. The writings of E.M. Rogers (1995), Stockdill and Morehouse (1992), and others have shown us that adoption, far from being a spontaneous, hit and miss, mystical act, is, at least in theory, the result of a fairly well defined, orderly process. Rogers' Innovation-Development Process, for example, has six stages ranging from "Needs/Problems" to "Consequences."

A second important contribution of the diffusion literature to IT is the idea that adoption is a very individualized, complex, and interconnected act. This would seem to directly contradict the previous finding, and in many ways, it does. We know from the adoption literature that individuals decide to adopt or reject an innovation for a variety of social, personal, psychological, and technical reasons (Tessmer, 1990; Farquhar & Surry,

1994). At first glance, adoption decisions, like most human decisions, may appear irrational or capricious. The diffusion literature has given us the tools to examine adoption decisions more closely. The literature has provided a framework to analyze the decisions of potential adopters and, at least on a rudimentary, highly fallible level, has allowed us to predict an innovation's chances for success within a specified environment.

Highlighting the crucial role that non-technical factors play in the adoption of an innovation is another major contribution of the diffusion literature. The idea that technological superiority is the most important factor in facilitating the adoption of an innovation is, thankfully, beginning to be widely rejected by researchers and developers alike. The adoption and diffusion literature, often citing the classic case of the Dvorak and QWERTY keyboards, has given us numerous examples of innovations that failed in spite of their technological superiority. It's comforting for those of us in the field of technology to believe that superior technology will always be attractive to potential users, but it is a fallacy. MacKenzie (1996) may have summed this point up best when he wrote: "Technologies . . . may be best because they have triumphed, rather than triumphing because they are best" (p. 7).

The diffusion literature has also contributed to IT by dividing innovations into macro-level innovations and micro-level innovations -- "Big Technologies" and "Little Technologies" as Cardwell (1995) calls them. Because of the diffusion literature, our definitions of the terms "technology" and "innovation" have subtly changed. In the past, we thought about innovations in localized, modular terms. An innovation was a new tool or a distinct modification to a larger process -- a new computer-based training program or an innovative instructional technique. Diffusion literature has taught us that innovations

can also be holistic and systemic. In many ways, this emerging idea of the macro-level innovation has paralleled instructional technology's gradual shift away from a product creation focus towards a focus on systemic change.

The diffusion literature's emphasis on the consequences of an innovation, good and bad, intended and unintended, represents another contribution to the field of IT. Innovations do not exist in a vacuum, but, for many years, it was common for technologists to minimize, or completely ignore, the impact their innovations would have after they were adopted. In reality, however, innovations have a way of resulting in unpredictable, sometimes benign, sometimes horrific, consequences after they have been adopted. Tenner (1996) describes the various ways that a new technology can have unintended negative consequences. He labels these negative consequences "Revenge Effects" and divides them into five possible categories: Rearranging Effects; Repeating Effects; Recomplicating Effects; Regenerating Effects, and; Recongesting Effects. Of course, there can be unintended positive effects of innovations as well.

Unexplored Areas of Diffusion Research

As described in the previous section, research into the adoption and diffusion of innovations has made several important contributions to the field of IT. The purpose of this paper, however, is to talk about gaps in the literature. We hope that this paper will point out areas of research that would be informative to the field and fruitful for those interested in diffusion theory and innovations research.

In thinking about unexplored areas of diffusion research, we began by writing down questions we had and ideas for studies we would like to conduct. After jotting down a number of different points, more or less off the top of our heads, we noticed two

very interesting things. First, we noticed that all of the questions we had focused on the human and social aspects of innovations. This focus is attributable, in part, at least, to our own on-going interest in the social and human aspects of technology. However, the focus on social and human aspects of technology is not unique to us. Many writers, most notably Jacques Ellul, have focused on this same area. Ellul, in his classic work "The Technological Society" writes that "it is no longer the frontiers of science which are at issue, but the frontiers of man; and the technical phenomenon is much more significant with regard to the human situation than with regard to the scientific" (p. 9). So, in a way, all of the ideas discussed in this paper really deal more with "people questions" than "technology questions."

The second thing we noticed when jotting down questions we had and ideas for research that we would like to conduct is that the questions could be grouped into five categories. Four of these categories are fairly well-defined, easy to describe, and "neat" while one is more "fuzzy" and may merely be a subset of one or more of the other categories. We will label the four "neat" categories of diffusion questions: Interaction of Adopter Groups; Adoption Versus Retention, Product Versus Process and; Technical and Societal Accommodations. We will label the fifth ("fuzzy") category "Perspectives of Innovation" because it deals with the different way that developers and users think about technology.

Each of these five categories is discussed in some detail in the following section. For each category, we begin with a brief description of the category. Following this, we will provide a sample research question and a hypothetical case that might be appropriate for illustrating the question. A few examples of research methodologies that might be

most useful are also included for each category.

Category #1: Interaction of Adopter Groups

Perhaps the most glaring shortcoming of the adoption and diffusion literature is the notion of the single adopter. The literature, and the studies based on it, often present the adopter as a single person or as a single, more or less, homogenous group. In the vast majority of real-world situations, however, decisions related to the adoption of an innovation involve several groups. These groups often make their adoption decisions at different times and often have minimal interaction with one another. To confound the issue even more, it is not uncommon for different adopter groups to have competing interests.

There are many reasons for the continuing misconception of the single adopter. The reason that is most common, and perhaps most difficult to overcome, is that adoption studies tend to test small parts of the overall model. A common type of diffusion study (e.g., Ross, 1983; Eads, 1984) investigates how the perceived attributes of an innovation influence the decisions of potential adopters. These studies are useful but not holistic. They ignore the multi-level nature of most organizations. One potentially fruitful area of study would be to examine how different groups -- people at different levels in an organization --- influence each other's decision to adopt or reject an innovation.

Hypothetical case. A large university installs a new state-of-the-art distance learning facility. The deans of several colleges at the university schedule courses for the new facility. Several departments are contacted and a number of faculty either volunteer or are assigned to teach distance learning courses. Students on campus and at remote sites sign up for the courses. By the beginning of the semester, the distance learning

facility is completely booked and most sections are full.

This case shows that the adoption of an innovation has to take place at several levels. If any of the groups -- administrators, deans, faculty, and students -- had not adopted the innovation, then the innovation would have failed. Of course, in the above example, the administration could have ordered everyone to use the new facilities. If that were so, it can be argued that this could be an example of a single-level adoption situation. But, even if the administration did use power tactics to "force" the adoption of the innovation, the nature of the tactics, and the response of the other adopter groups to those tactics, would make for an interesting and important study.

Research question. How do university administrators, deans, faculty, staff, and students interact to facilitate or impede the adoption of an innovation at a university?

Research methodology. Like most research questions, a number of techniques could be used to study this hypothetical case. The ideal study would use a longitudinal method to study each step of the process. On-going observations and interviews with members of the different adopter levels would produce valuable information. If their study were conducted on a post-hoc basis, interviews, questionnaires, surveys, document analysis, and focus groups could be used. Sociometric analysis, the study of choice, interaction, and communication patterns (Kerlinger, 1973), might also be useful in investigating questions of this type.

Category #2: Adoption Versus Retention

Most studies based on the adoption and diffusion literature seek to determine the factors that facilitate or impede the initial adoption of an innovation. Even though much of the adoption literature, especially that based on the Rogers Model, correctly stresses

that adoption and retention are parts of the same process, few studies have investigated the factors that facilitate or impede long-term retention of an innovation. There are two rather obvious reasons for the lack of research into the area of retention. First, and most importantly, the study of retention factors requires a long-term commitment of time and money. Retention is, inherently, a long-term process. To properly study the retention of an innovation, a researcher would have to have a long, on-going involvement. Second, researchers tend to focus on adoption, rather than long-term retention, as the ultimate goal of the process. Much of the adoption and diffusion literature has a deterministic bias -- it assumes that once an innovation has been adopted, it will continue to be used. As we know, however, the initial adoption of an innovation does not guarantee its continuing usage. Many interesting and important studies could be conducted to determine what factors are important to the continuing retention of an innovation after it has been adopted.

Hypothetical case. An inner-city high school has received a large grant to purchase a computer-based algebra course. All algebra teachers have attended training sessions on the new modules and students have been assigned to classes. After three years, the CAI algebra modules are still in use and most teachers, students and parents seem happy with the results.

Research question. Are the factors that lead to the adoption of an innovative CAI module at an inner-city high school different from the factors that encouraged the long-term retention of the CAI module?

Research methodology. This is really a two-part study. The researcher would have to first determine which factors were influential in facilitating the adoption of the

innovation and then determine the factors that were influential in the innovation's retention. Once again, the best methodology would be for a longitudinal study with the same researcher investigating both the adoption and the retention of the modules. An alternative design would be to do a post-hoc study of the adoption factors and then use observations, interviews and focus groups to determine the retention factors. A third approach would be for a researcher to find an older study, conducted by someone else, that sought to determine the factors that influenced the adoption of an innovation. The researcher could then return to the site of the older adoption study and investigate the factors that have facilitated the retention of the innovation.

Category #3: Product Versus Process

When technologists discuss innovations, they are, most likely, talking about product innovations -- tools and hardware. Thinking about innovations only as tangible things, however, is a far too narrow way of thinking. In addition to being tangible things, innovations can, of course, be ideas, new practices, or improved processes. Diffusion theory doesn't make any distinction between product innovations and process innovations. In fact, some of the most important adoption studies (e.g. Kivlin and Fliegel. 1967) have dealt with the adoption of process innovations.

Even though the literature makes no distinction between product and process innovations, the majority of adoption studies in the field of instructional technology have concentrated on studying product innovations. Adoption studies related to instructional technology (e.g., Gbomita, 1997), almost always examine the adoption and diffusion of product innovations -- most commonly computers. One reason for this is that the adoption of product innovations is fairly concrete and easy to define -- an innovative

computer program is either purchased and used or it isn't. Process innovations are far less well defined. It's possible, for example, to incorporate some constructivist principles into the classroom without totally changing the nature of the classroom. It's often difficult to tell (and harder still to empirically document) when innovative practices reach the level where they can be called "adopted." Despite the inherent difficulties, the study of process innovations is a potentially rich area of instructional technology research. The study of process innovations could reveal adoption factors that are different from those found in the adoption of product innovations. As instructional technology moves away from its focus on tools and towards a focus on systemic change, the study of process innovations will become increasingly more relevant and valuable.

Hypothetical case. The State Board of Education has passed a resolution that encourages schools to teach all mathematics lessons in grades 2 through 4 by ability grouping instead of the more traditional age grouping. Students with similar levels of mathematics skill should, according to the Board, be taught in the same classes, regardless of what grade they are in. The Board of Education has left it to local School Districts to implement the resolution as they see fit.

Research question. What factors were most successful in facilitating the adoption of mathematics ability grouping by schools throughout the state?

Research methodology. Even though this is a study dealing with a process innovation, not a product innovation, the same methodology (e.g., Kivlin and Fliegel. 1967) can be used with some success. The diffusion researcher would probably examine the perceptions that local teachers had in regard to the innovation's attributes and then seek to determine which attributes (complexity, compatibility, observablity, relative

advantage, and trainability) played a role in the teachers' decision to adopt the product. In addition to studying the attributes of the process innovation, the researcher could focus on the efforts of change agents, probably either the local school boards or the principals, at different locations to study the most effective strategies for encouraging the adoption of the innovative process.

Category #4: Technical and Societal Accommodations

In a world of uncertainty and doubt, it is always reassuring to have a certain set of facts that are known, or at least generally accepted, to be true. There aren't many things that we know are certain, but every major author on the subject of technology (e.g., Cardwell, 1995; Segal, 1994) agrees that society and technology influence each other. While there are currently raging debates as to the nature of the influence and whether science or technology plays the primary role in change (Kaplan, 1996; Bromley, 1997), the existence of an inseparable link between the two is unquestioned. Bromley (1997) has developed an interesting model that might be useful for thinking about this issue. His "Model of Technology-Society Interaction" divides the life cycle of a technology into the context of development and the context of use. Bromley contends that technology and society interact both during the development of an innovation and during the use of the innovation.

So, if we accept that science and technology do impact each other, what implications does this have for researchers? The most obvious implication is that researchers should concentrate on investigating the specific ways that society and technology impact each other and the results of that impact. We need more research into how the social environment -- the practices, habits, goals, hopes, fears, skills,

philosophies, and plans of people -- influence the way an innovation is used. We also need to know more about the ways an innovation influences the social environment in which it is used.

Our hypothesis is that a series of accommodations takes place, over time, whenever an innovation is adopted. By accommodations, we mean compromises and subtle changes by both the society and the technology. We think it is realistic to hypothesize that people alter their goals, practices, and beliefs to accommodate an innovation. It is equally likely, we believe, that successful innovations change to accommodate the needs, hopes, and desires of the people who use it.

Hypothetical case. A rural school district has purchased a multimedia teaching station for each of its 8 schools. This teaching stations consist of a high-end Macintosh computer with authoring and presentation software, speakers, a color scanner, and a LCD panel / high-intensity overhead projector on a mobile cart. Each school is allowed to use their teaching station any way they want.

Research question. What types of technological accommodations and societal accommodations take place when a multimedia teaching station is adopted by a rural school?

Research methodology. This is another example where an ongoing study is called for. The researcher would have to make a commitment to study the situation over time. The most effective studies of this type would begin by examining the social environment before the innovation was adopted. If a pre-adoption study is impossible, the researcher would again have to use a variety of post-hoc methods--interviews, document analysis, focus groups, surveys, etc. -- to determine pre-adoption societal norms. Then the study

would have to look at what accommodations were made in the use of the stations by each school and try to determine if those accommodations were due to the social environment or other factors. This could then be compared with what changes occurred within the social environment because of the stations.

Category #5: Perspectives of Innovation

This is the "Fuzzy" category we mentioned earlier. As part of one of our doctoral dissertations (Surry, 1993) developers of a series of CAI modules about Doppler Radar were interviewed. Many of the weather forecasters who used the training modules were also interviewed. Over the course of the study, it became obvious that the developers and the weather forecasters saw the CAI modules in very different ways. The two groups used different terminology when discussing the modules and pointed out different aspects for the modules when asked about the advantages and disadvantages. It's hard to explain, but in talking to the two groups, one got the feeling that each group had an entirely different perspective on the modules, in particular, and technology, in general.

Do instructional developers and technology users have fundamental differences in the way they think about a particular innovation or about technology in general? If so, where do the philosophies of the two groups differ and where are they similar? If differences exist, how do they influence the adoption of a product? Are developers of technology aware of the philosophical perspectives of potential adopters? If so, how did they become aware of those perspectives? These are all questions that have potential for instructional technology researchers.

Summary

In this paper, we have discussed a number of gaps in the research related to the

adoption of instructional innovations. The focus of the paper has been that more research needs to be done into the interaction of technology and people. We hope that this paper will encourage others to become interested in the study of adoption of innovations. We also hope this paper will encourage other researchers in the area to focus on the impact that technology has on people. In closing, there is a quote from Ellul's "The Technological Society" that we would like to share:

> It is not, then, the intrinsic characteristics of techniques which reveal whether there have been real changes, but the characteristics of the relation between the technical phenomenon and society. Let us take a very simple comparison. A shell explodes and the explosion is normally always the same. Any fifty shells of the same caliber when exploded display approximately the same objective characteristics from a physical or chemical point of view. The sound, light, and projection of fragments remain nearly identical. The intrinsic characteristics of the fifty explosions are the same. But if forty-nine of the shells go off in some remote place and the fiftieth goes off in the midst if a platoon of soldiers, it cannot be maintained that the results are identical. A relation has been established which entails a change. To assess this change, it is not the intrinsic characteristic of the explosion which must be examined, but rather its relation to the environment (p. 63).

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